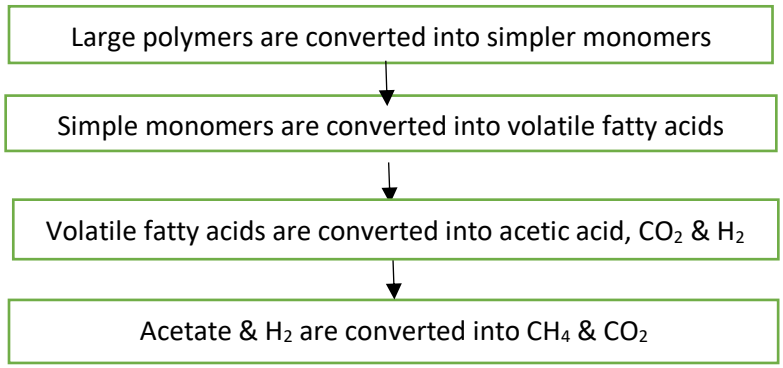
Bio-Digester Toilet

An Eco-friendly Sanitation Technology

1. Introduction :

Nepal Red Cross Society has introduced a bio-digester faecal sludge management technology at household level with the aim to provide a plausible solution to address the extreme sanitation gap in Nepal. If successful, this technology can solve the need for faecal sludge management at household level and help to create an environment free of faecal contamination. The inoculum for the bio-digester technology has been in use for over two decades by the Indian Army with great success over a wide variety of environmental conditions and contexts. The technology is going through a commercialization process in India resulting to it being introduced as a viable solution to the sanitation problem in India. The proof of concept has been done in India but still the challenges and an objective database on its performance is still required for it to be considered a viable robust solution to FSM globally.



Simple engineering is required to allow anaerobic conditions for the bacteria to survive and consume faecal matter resulting in: negligible build-up of any solids; effluent that is almost pathogen free – pathogen inactivation has been measured at 99%; effluent that is odour free; and most importantly the return of a safe resource back to the environment as water. The technology is relatively low cost, with only the adaptation of the septic tank to be a closed system and passive requiring no moving parts or inputs of energy besides a regular supply of human faecal matter. The superstructure remains the same lending any latrine to be easily adapted to the technology. The consortium of bacteria can withstand a wide range of environmental conditions from extreme cold (-40 degrees centigrade) to extreme hot (+50 degrees centigrade) with consumption of solids occurring within the first 24 hours allowing the technology to be appropriate for emergencies, camp like settings, informal settlements, both rural and urban type settings (Claimed by DRDO).

Why are Bio-digester Septic tanks needed?

Annually 730 tons of human faecal matter is discharged to rivers, lakes, oceans and other water bodies[1]. Such an abhorrent practice results in the contamination of precious water resources, food and land as well as further propagation of diseases by vectors. This is further compounded in those areas of the world where open defecation is still practiced. Proper handling and disposal of faeces are key to reduce the burden of diarrheal diseases. This is coupled closely with the need for the right behavior change triggers to ensure personal and environmental hygiene is adopted.

Diarrhea is considered one of the leading causes of death for children under the age of five, killing annually more than AIDS, malaria and measles combined. In addition, under nutrition is both a cause and a consequence of diarrhea. Mal-nourishment increases both the susceptibility to diarrhea and the severity of episodes, and WASH-related pathogens (especially those causing diarrhea) leading to reduced food intake and the mal-absorption of nutrients (Checkley et al. 2008; Lima et al. 2000).

Worldwide, approximately 160 million children under the age of 5 are stunted. This means they are failing to grow well. The lack of height can be considered as a marker for a whole range of developmental setbacks including cognitive impairment. The lack of adequate safe or improved sanitation can be considered as one of the major development setbacks from which unsafe handling and or dumping of faecal sludge uncontrollably into the environment can be considered as a major contributing factor (Sanitation, WHO).

The current rate of urbanization poses an imminent risk to public health, especially where inaccessibility to sanitation facilities are taken into account. Improving sanitation will therefore be key to addressing some of the public health issues, but on the other hand also particularly challenging in areas that are rapidly growing. In such circumstances, the need to empty septic tanks usually results, mainly due to cost but also unavailability of facilities to adequately process waste, in the waste being dumped in an uncontrolled way at a detrimental impact to the environment.

Most technologies that involve bio-degradation of faecal matter are susceptible to season variations in temperature Therefore a technology that can cater for such diverse conditions and be adaptable to both a wide range of temperatures and locations within the environment is a major challenge.

Nepal has been identified due to its added complexity of increasing urbanization and lack of infrastructure to deal with on-site sanitation and appropriate FSM. From a research perspective Nepal has been identified due to its varied climatic and physical environments that make it suitable to test how the technology performs and the potential challenges to be overcome. Additionally, due to the high population densities in urban centers and their respective access to markets would make the technology potentially economically viable for local business to take on as an eventual low cost technology to be scaled up.

2. Why Nepal is selected for trial?

[1] https://www.un.org/waterforlifedecade/swm_cities_zaragoza_2010/pdf/facts_and_figures_long_final_eng.pdf

IFRC has selected Nepal to introduce the Department of Research and Development Organization (DRDO) technology based on the following criteria:

Nepal has been chosen to try and address the need for onsite management of sludge which in urban and peri-urban contexts the common practice is to discharge faecal sludge to the environment via surface waterways posing not only an evident public health risk but also downstream contamination of both surface and groundwater supplies. Additionally, due to the wide range of temperatures experienced in Nepal it has been deemed a good location to test how the inoculum performs given the claims by the DRDO of its effectiveness especially at colder sub-zero temperatures. The chronic over population within its main urban center would also mean that more innovative solutions need to be found and scaled up to deal with untreated sludge being handled and discharged. The Nepal Earthquakes of 25 April and 12 May have rendered significant number of houses without onsite sanitation and therefore the plan is to use the opportunity to add the inoculum to targeted septic tanks following an adaptation of the existing design as part of the recovery programme. This component of the scale up will be implemented following successful trialing in a controlled fashion of 8 pre-identified households within peri-urban settlement in Kathmandu valley;

3. Selection of Households

Initially Nepal Red Cross had selected the households in slum area. It had tested bio-digester in two households without inoculum bacteria only using cow dung. Latter, households had shifted from the location due to extension of roads. Therefore no complex testing and research could be performed for the trial run with only cow dung.

Latter NRCS has selected households by coordination with Earthquakes Recovery Program in Kathmandu district. By two phases, the total 8 households selected in Tarkeshwar Municipality-7 with community recommendations among non-toilet households. 1st phase in 2016/2017, 4 households selected and constructed the bio-digester tanks. 2nd phase in 2017/2018, additional 4 households selected and constructed.

4. Approval of Inoculum Bacteria use in Nepal

IFRC/NRCS had submitted the custom clearance documents for transportation of inoculum bacteria from India and use it in intended purpose in Nepal. Due to lack of information of its composition and functions among experts in Nepal, it took almost a year to get approval from Nepal Government. In the meantime, experts from Ministry of Health had visited manufacturing company and bio-digester toilets in India.

5. Inoculum Bacteria transportation from India

IFRC has procured inoculum bacterial by a license holder company in India and transported it through land to Nepal. It was transported in field and was inoculated in bio-tanks as per instruction by manufacturer.

6. Construction of bio-tanks

The bio-tanks were constructed as per approved design by DRDO for a household. The design were based on brick masonry. With the technical orientation and mobilization of local masons, the construction was successfully completed with close technical monitoring by NRCS engineers. After completion of construction and before used by households, the operation and maintenance orientation to household members were given with technical experts.

7. Reed Bed construction with bio-tanks

For increment the quality of affluent water, reed beds were constructed in 7 bio-tanks out of 8. The design of reed bed was based quantity of affluent water from bio-tanks per day.


8. Laboratory test (Result)

The main objective of lab test was to check affluent quality of discharge is within limitation of Nepal standard and with DRDO claims. 1st phase testing of four households were analyzed by experts. It seems that result is gradually coming within government standards in general. 2nd phase testing is undergoing until December, 2019. Bio-Tank effluent quality, primarily measured by Faecal coliforms, TDS, BOD, COD, and other parameters and considering temperature range and fluctuation. Effluent quality tests that examine a range of parameters have been carried out weekly from Oct 2017 on the first 4 household bio-digester tanks built, and tests will be extended to include the next 4 bio-digesters which are to be completed by December 2019.

9. Research of Bio-digester tank by External consultants

IFRC/NRCS had hired an external consultant to research the efficiency and effectiveness of bio-digester toilet. Following conclusions and recommendations has been drawn by consultant.

Conclusion:

The bio-digester system has not yet met DRDO expected performance consistently and is often some way off. IFRC/NRC has invested considerable time, effort and some funds to get this far so it is worth continuing testing into next year in order to try to get better performance and data out of the bio-digesters. IFRC/NRC need to deal with the following issues before wider dissemination;

a) Getting all systems fully installed, operating and getting effluent dataset.
b) Measure sludge build-up over 2, ideally 3 years.
c) Build smaller sized bio-digester tanks and test performance of these. Effluent data would then be required for a full year of operation.
d) Get predicted construction costs down.

Recommendations:

- IFRC/NRCS extend project monitoring and further system evolution and testing.
- IFRC in Kula Lumper regional office and Geneva head office seek to clarify the licensing and operational issues with DRDO in India.
- It is suggested a virtual exchange/learning group is set up between Philippines/Nepal/ Lebanon and perhaps India.
- NRCS look to develop a relationship with Kathmandu University, who have reported they are already undertaking work on another type of bio-digester. This will help with credibility, acceptance and analysis.
- NRCS hold initial discussions with government and UN agencies about how site sanitation systems that might be suitable for meeting SDG 6 /Nepal total sanitation plan can be assessed. The criteria developed as part of this work should be used as a basis for kick starting these discussions.

10. Regular monitoring by NRCS team

Initially, fortnight interval and gradually monthly interval, NRCS technical experts had regularly monitored to households and collected their feedbacks. During the monitoring, it was also collected information about preferences and acceptance.